FINAL PROGRESS REPORT

R21HS024335

Using Social Knowledge Networking Technology to Enable Meaningful Use of Electronic Health Record (EHR) Technology

PI: Pavani Rangachari, PhD

Augusta University

(*Formerly, Georgia Regents University*)

November 1, 2018

Title Page

Project Title:

- "Using Social Knowledge Networking Technology to Enable Meaningful Use of Electronic Health Record (EHR) Technology"

Principal Investigator (PI) and Key Personnel:

- Pavani Rangachari, PhD (PI)
- Kevin Dellsperger, MD, PhD (Co-I)
- David Fallaw, MD (Co-I)
- Ian Davis, MD (Co-I)
- Michael Sumner, MD (Co-I)
- Walter Ray, CISSP (Co-I)
- R. Karl Rethemeyer, PhD (Consultant)

Project Organization:

- Augusta University (Grantee Institution)

Project Period:

- September 30, 2016-September 29, 2018

Project Officer:

- Janey Hsiao, PhD

Acknowledgment of Agency Support:

- This project was supported by grant number R21HS024335 from the Agency for Healthcare Research and Quality (AHRQ).

Grant Award Number:

- R21HS024335

Structured Abstract

Scope: Similar to issues faced in health systems across the U.S., AU Health faced a scenario of low physician engagement in, and limited-use of its Electronic Health Record (EHR) Medication Reconciliation (MedRec) technology, which in turn, translated to high rates of medication discrepancies and low accuracy of the patient's active medication list, during transitions-of-care. In fall 2016, a two-year grant was secured from AHRQ, to pilot-test a Social Knowledge Networking (SKN) system pertaining to "EHR-MedRec," to enable AU Health to progress from "limited-use" of EHR-MedRec technology, to "meaningful-use."

Purpose: The aims of this study were to: **1)** examine dynamics of inter-professional knowledge exchange and learning related to EHR-MedRec on the SKN system; and **2)** explore associations between "*SKN-Use*" and "*Meaningful-Use-(MU)-of-EHR-MedRec*," with the latter being assessed in terms of adherence to best-practices in EHR-MedRec, i.e., practices known to reduce medication discrepancies and promote medication-list accuracy, during transitions-of-care.

Methods: Over a one-year period, 50 SKN Users (physicians, nurses, and pharmacists from outpatient-and-inpatient-medicine services), participated in discussing issues-related-to EHR-MedRec, moderated by 5 SKN Moderators (senior administrators). Qualitative (thematic) analysis was used to understand dynamics of inter-professional knowledge exchange; and quantitative (descriptive) analysis was used to examine trends in two EHR-MedRec-MU measures, identified for the study.

Results: Inter-professional knowledge exchange related to EHR-MedRec on the SKN, progressed from "problem-statements" to "problem-solving-statements-(the-how-to)," to "system-education-(the-what)," to "best-practice-assertions-(the-why)," to "culture-change-assertions-(the-way-to)," to "collective-learning-(aha)-moments," to lay a foundation for practice change. These dynamics in turn, were associated with distinct improvement trends in both EHR-MedRec-MU measures.

Conclusions: An SKN system could be valuable in enabling implementation of complex innovations (like MU-of-EHR-MedRec) in healthcare organizations, by addressing implementation-challenges in the correct sequence (e.g., facilitating collective learning of the value of best-practices, before IT-training of providers to address socio-technical challenges). Several strategies are identified for the creation of a "learning health system," to enable successful change implementation.

Keywords: *Electronic Health Records; Medication Reconciliation; Meaningful Use; Change Implementation; Social Knowledge Networks; Care Coordination; Inter-Professional Learning.*

Scope/Background

Medication reconciliation (MedRec) is a formal process for creating a complete and accurate list of a patient's current medications during transitions-of-care, e.g., outpatient-to-inpatient-to-outpatient care transitions for chronic disease patients on multiple medications. The process of MedRec comprises several key steps: (1) develop a list of the patient's current medications; (2) develop a list of the medications to be prescribed; (3) compare the medications on the two lists; (4) make clinical decisions to update the medication list, based on the comparison; and (5) communicate the updated medication list to *both* the patient/family *and* the next providers of care. The goal of MedRec is to reduce medication discrepancies during care transitions, and provide an accurate active medication list to patients and their next providers of care across the continuum, to promote patient safety and quality of care.

MedRec has been a part of the Joint Commission hospital accreditation requirements since 2005, and with the introduction of the HITECH Act in 2009, it has become part of the Electronic Health Record (EHR) "Meaningful Use" requirements. Meaningful Use (MU) of EHR MedRec technology in turn, refers to effective use of the "EHR MedRec" system by providers, to complete the MedRec process (as outlined above), to reduce medication discrepancies and promote medication-list accuracy, during care transitions.

Despite the regulatory impetus towards MU-of-EHR-MedRec however, hospital adherence has been found to lag due to low physician engagement in EHR MedRec, stemming in part, from lack of professional consensus about which physician (e.g., hospital vs. community physician) is responsible for managing a patient's medication list, and the value of MedRec as a clinical tool for promoting patient safety. Additionally, within the hospital context, the assignment of MedRec responsibilities among provider subgroups—multiple physicians, nurses, and pharmacists, —is often unclear, leading to inefficiency and potential for error. Consistent with these findings, several recent studies have found that although hospital EHR vendors have been enhancing MedRec functionality over time, numerous hospitals still use partially paper-based processes during care transitions. In other words, there is "limited-use" of EHR MedRec technology, in hospitals across the U.S, as opposed to "meaningful-use."

Problem of interest

Based in Augusta, Georgia, Augusta University's Health System, AU Health, is a health care network offering comprehensive primary, specialty and subspecialty care in the region. Facilities include a 478-bed AU Medical Center, more than 80 outpatient practice sites, a Critical Care Center housing a regional trauma center and a 154-bed Children's Hospital. The health system averages approximately 21,000 inpatient discharges and 90,000 emergency room visits per year. Medicare and Medicaid together account for over 50% of the patient care revenues.

In 2015, AU Health faced challenges (similar to those described earlier), with the use and implementation of its EHR MedRec system (which is powered by Cerner Inc., a federally certified EHR vendor). Although MedRec was often marked as "complete" on the EHR, before patient discharge from the hospital, AU Health leadership estimated the patient's active medication list to be inaccurate (with discrepancies between patient's home and hospital medication lists in regard to drugs, dosages, and frequencies), for a majority of discharged cases. Importantly, there was consensus among administrators, that the EHR MedRec system was not being used effectively to communicate changes in the active medication list across the provider continuum and to patients/families. This challenge in turn, was ascribed to the general reluctance of physicians to discontinue medications that they did not originally order (from the active list), which in turn, led to not only medication discrepancies during care transitions, but also to frustrations associated with inaccurate and incomplete medication lists, among patients and providers alike. In summary, AU Health faced a scenario that was reflective of national concerns related to use and implementation of EHR MedRec in hospitals/health systems, i.e., low physician engagement, translating to limited-use of EHR MedRec technology.

Purpose

In fall 2016, Augusta University secured a two-year grant from AHRQ, to pilot-test a Social Knowledge Networking (SKN) system pertaining to EHR MedRec, to enable AU Health to progress from "limited use" of EHR MedRec Technology, to "meaningful use." As discussed earlier, a primary reason identified in the literature for limited-use of EHR MedRec, is low physician engagement, emanating from an absence of shared understanding among providers of 1) the value of EHR MedRec in promoting patient safety; and 2) the EHR MedRec workflow, including the responsibilities of each provider group across the continuum of care. The rationale for an SKN, is that it could provide a platform for enabling tacit (practice-based) knowledge exchange on issues related to EHR MedRec, across diverse provider subgroups and care settings, to highlight adverse consequences of gaps in practice (for patient safety); and emphasize the value of adhering to best practices, which in turn, is expected to increase physician engagement in addressing the issues; and promote collective learning of best practices, to provide a foundation for practice change, i.e., MU-of EHR-MedRec. This paper discusses the methods and results associated with two specific aims of this study:

Aim 1. Examine the dynamics of inter-professional knowledge exchange and learning related to EHR MedRec on the SKN system.

Aim 2. Explore associations between "*SKN Use*" and "*Meaningful Use (MU) of the EHR MedRec system*," with the latter being assessed in terms of adherence to best-practices in EHR MedRec, i.e., practices known to reduce medication discrepancies and promote medication-list accuracy during care transitions (as described under "Methodology").

Theoretical Framework

The theoretical foundation for using an SKN to facilitate engagement, inter-professional learning and practice change (i.e., MU-of EHR-MedRec), emanates from integrating two literature streams: 1) Professional Complex Systems Theory and 2) Social Network Theory. Complex systems theory has strongly reinforced the message that there can be no organizational change without organizational learning, and that the latter in turn, requires the exchange of tacit (practice-based) knowledge, to facilitate engagement and collective learning. Congruently, the literature on social network theory, has sought to understand which communication network structures may be most effective for tacit knowledge exchange, engagement, learning, and change, in complex systems. Studies in this niche, have put forth that although peer-to-peer networks rich in "density," may be more effective in "complex systems," networks rich in "brokerage" and "hierarchy" may be more effective in "professional complex systems (PCS)," i.e., organizations exhibiting properties of both professional organizations and complex systems, like healthcare organizations (HCOs).

In other words, the literature suggests that *proactive and periodic top-down communications may be most effective for tacit knowledge exchange, engagement, learning, and change in PCS*. The reasoning, is that PCS contain multiple professional subgroups with "subgoals" that are reinforced through ongoing in-group communication. This in turn, results in an absence of cognitive linkages across subgoals, and between subgoals and organizational goals. Therefore, under conditions of change, senior administrators must undertake proactive and periodic efforts to create cognitive linkages between subgoals and organizational goals, to enable tacit knowledge exchange, engagement, learning, and change. In summary, this theoretical framework (**Figure 1**) suggests that Social Knowledge Networks (SKN) moderated by administrators, to engage provider subgroups in tacit knowledge exchange on practice issues (related to EHR MedRec), while also facilitating proactive, periodic, top-down communication on best-practices related to EHR MedRec, can foster collective learning and practice change (e.g., MU-of EHR MedRec), in HCOs.

Methods

A prospective and exploratory mixed-method design was used for data collection & analysis. The crux of the project was a pilot-implementation of a moderated SKN system on issues related to EHR MedRec, over a one-year period; April 1, 2017-to-March 31, 2018 (i.e., Q2 2017-through-Q1 2018), among diverse provider subgroups and care settings, i.e., physicians, nurses, and pharmacists from outpatient and inpatient medicine settings at AU Health.

Design & implementation of SKN system on EHR MedRec

The SKN system implemented at AU Health, included several components:

- ***SKN Reporting Tool***: an online form that allowed participating providers (SKN Users) to report issues related to EHR MedRec, by providing a brief description of the issue and indicating the care settings and patient conditions it applies to.
- ***SKN Discussion Tool (Microsoft Yammer)***: an online platform (independent of the SKN Reporting Tool), to enable moderated discussions on issues related to EHR MedRec. Microsoft Yammer is an example of an enterprise SKN system. Our study used the basic version of Yammer, which was already available to AU as part of its Office 365 package.
- ***SKN Lunch-and-Learn Sessions***: A total of 5 Lunch-and-Learn sessions were held over the one-year SKN period, for participants to meet and discuss lessons learned from exchanges on SKN Yammer. Advance invitations to these sessions were sent to *all SKN participants.*
- ***SKN Periodic Email Updates***: Approximately 15 periodic progress update emails were sent by the Principal Investigator (PI) to *all SKN participants*, over the one-year SKN period.

There were two types of users of the SKN system:

1. ***SKN Moderators***: included a group of 5 senior administrators and provider champions who played a key role in moderating discussions on issues related to EHR MedRec among participants (SKN Users) over the one-year SKN period. The 5 SKN moderators included the Chief Medical Officer (CMO), Chief Medical Information Officer (CMIO), two hospitalist chiefs, and the Principal Investigator (PI). A key responsibility of SKN Moderators was to bring issues related to EHR MedRec reported on the SKN Reporting Tool, for discussion by all SKN Users on Yammer. While SKN Moderators would bring the brief issue-descriptions to Yammer, they would not reveal the identity of the person reporting the issue, to enable SKN Users to maintain a level of confidentiality in reporting issues. As such, a majority of threads-of-discussion on Yammer began with an issue-report brought to Yammer by SKN Moderators. SKN Moderators also played a key role in proactively initiating discussions on topics relevant to EHR MedRec (e.g., best practices identified in the literature), and in bringing lessons learned from the SKN system, for discussion at regular health system meetings, including the Hospital Quality Council, chaired by the CMO.
2. ***SKN Users***: included 50 practitioners, i.e., physicians, nurses, and pharmacists from outpatient and inpatient medicine services at AU Health, who agreed to participate in the SKN system. Key responsibilities of SKN Users were to 1) report issues related to EHR MedRec on the SKN Reporting Tool; 2) participate in moderated discussions on SKN Yammer; and 3) share lessons learned from their ongoing participation on the SKN, with colleagues in the health system. However, SKN Users were *not allowed* to initiate (or create) new threads-of-discussion directly on SKN Yammer. This ability was restricted to SKN Moderators, to enable coordinated discussions of issues related to EHR MedRec on the SKN.

Participant recruitment and orientation

Participant recruitment to the SKN system, began after the project received IRB approval from Augusta University. All practitioners in three professional subgroups, i.e., physicians, nurses, and pharmacists, in inpatient and outpatient medicine services at AU Health, including Cardiology, Internal Medicine, Family Medicine, Emergency Medicine, and Hospitalist service lines, were approached by the PI for recruitment using the IRB-approved informed consent process. A total of 50 practitioners were recruited to participate as SKN

Users, including 15 physicians, 15 nurses, and 20 pharmacists, from outpatient and inpatient medicine settings. [1] It would be relevant to note, that there were a total of ~200 eligible medicine service practitioners (physicians, nurses, and pharmacists) at AU Health. As such, by recruiting 50, we achieved a dual goal of 1) reaching our recruitment target for this pilot study; and 2) attracting a critical mass of over one-fourth of the total number of eligible practitioners at AU Health.

Everyone who agreed to participate, was requested to review and sign: 1) an Informed Consent document, 2) a Statement of Professional & Ethical Conduct on SKN; 3) an SKN Privacy & Confidentiality Agreement, which stressed that use of Protected Health Information (PHI) anywhere on the SKN system, was strictly prohibited; and 4) a Custom Usage Policy, which clarified that SKN Users were not allowed to initiate threads-of-discussion directly on SKN Yammer; they would only report issues though the SKN Reporting Tool. For coordination purposes, only SKN Moderators would have this ability. Participants then received a detailed online orientation to the SKN system, prior to its launch, including steps for accessing the SKN Reporting Tool and SKN Yammer, which were made available to participants through separate links within the EHR. Both tools were also accessible through the enterprise employee web portal and mobile devices; and Yammer was downloadable as an App. A participant engagement plan, including follow-up emails to participants and quarterly distribution of $25 gift cards to selected participants, was implemented over the one-year SKN period, to ensure that the SKN was being used for its intended purpose.

Data collection and analysis

Data collection

***SKN Use*:** Data on SKN Use was collected over the one-year SKN period. A key data source was Yammer, which included a record of all communications posted by SKN Users, on various threads-of-discussion related to EHR MedRec. A majority of these threads in turn, stemmed from issues reported by SKN Users via the SKN Reporting Tool. *All* threads-of-discussion on Yammer, were open and available to *all* SKN Users, without restriction. Yammer recorded the name, date, and time associated with each posting. Additional data sources related to SKN Use included the SKN Reporting Tool; the 15 SKN progress email updates; and the 5 SKN Lunch-and-Learn sessions, which were held in April 2017 (Q1 of SKN period), July 2017 (Q2), October 2017 (Q3), February 2018 (Q4), and May 2018 (after SKN implementation). Each Lunch-and-Learn session lasted ~60 minutes; and was attended by ~20 participants. All sessions were audio-recorded and transcribed to text, to enable Thematic Analysis.

***Meaningful Use (MU) of EHR MedRec*:** Data on MU-of-EHR MedRec consisted of measures of two best practices in EHR MedRec, i.e., practices known to reduce medication discrepancies and promote medication-list accuracy during care transitions. Due to the exploratory nature of the study, the decision to use these measures, emerged from the inter-professional knowledge exchange dynamics on the SKN, during the first few months of the SKN period. Since both were practice measures, they could be captured retrospectively from the EHR. Data on these measures was collected over 6 quarters, i.e., Q1 2017 through Q2 2018. This translated to one quarter before SKN was launched, extending to one quarter after SKN was concluded:

MEASURE 1: External Rx History Import (*Higher is Better*): Defined as the aggregate proportion of patient encounters during which the External Rx History was imported at some point before the encounter ended (inpatient or outpatient). Data was obtained at the encounter level, quarterly, for 6 quarters, for each of the 5 medicine services represented on the SKN, and aggregated, to examine trends in the proportion of External Rx History Import. Since Cardiology was the only medicine *subspecialty* represented on the SKN, this measure was restricted to patient encounters for a Cardiology-relevant chronic condition, i.e., patients who had a primary or secondary diagnosis of Congestive Heart Failure (CHF), based on ICD-10 codes.

[1] All participating physicians from Cardiology, Internal Medicine, and Family Medicine, practiced in both inpatient and outpatient settings. Only Hospitalists were exclusively inpatient practitioners.

"External Rx History Import" refers to the importation of the patient's medication history filled at their pharmacy. This Rx history can be imported when the provider activates the External Rx History button on the EHR, which in turn would access the Surescripts system to pull the patient's Rx history. Surescripts is an IT company that supports e-prescription, the electronic transmission of prescriptions between HCOs and pharmacies. According to the US DHHS, in 2014, 96% of US community pharmacies used the Surescripts network. At AU Health, it was determined that 90% of patients fill their prescriptions at pharmacies that participate in the Surescripts system. External Rx Import (MEASURE 1) is a measure of MU-of-EHR-MedRec, because a higher proportion reflects better use of the EHR system by providers, to obtain a current medication list, for reconciling with new prescriptions, to reduce discrepancies and increase medication-list accuracy, during transitions-of-care.

MEASURE 2: Missing Documentation of Compliance Status (*Lower is Better*): Is defined as the aggregate proportion of patients' total active medications that are missing documentation of "Compliance Status." Data for this measure was collected at the patient level, quarterly, for 6 quarters, for all patients who had a primary or secondary diagnosis of CHF, and at least one encounter with any one of the 5 medicine service lines represented on the SKN, over the 6-quarter period. There were a total of 2,846 individual patients who met these criteria.

The aggregate proportion of missing compliance status documentation was calculated for all patients with reported active medications by quarter, to examine trends over the 6-quarter period. It is essential for all medications on a patient's active list to have a documented (non-missing) "Compliance Status," so that the next provider is equipped with information needed to accurately update the list, before the subsequent transition point. For example, if Compliance Status for a medication is "unable to determine" in the ED, the admitting hospitalist might talk to the patient/family to update the status to "still taking as prescribed." On the other hand, if the medication is determined to be "not taking," because its course has been completed, then it could be removed from the list, prior to discharge. "Missing Compliance Status Documentation" (MEASURE 2) is a measure of MU-of-EHR MedRec, because a lower proportion reflects better use of the EHR system by providers, to communicate changes in the patient's active medication list, across the continuum of care, in an effort to reduce medication discrepancies and promote medication list accuracy during transitions-of-care.

In summary, both measures reflect effective use of EHR MedRec system functionalities by providers, to reduce medication discrepancies and improve medication-list accuracy. It would be relevant to note, that both measures are designed to capture practices implemented by a team of providers; in that, they could be completed by a physician, nurse, or pharmacist in a particular service line, caring for the patient in the hospital or clinic. As such, it would not be feasible to track adherence to these practices for patients cared for only by the specific providers who participated on SKN. However, it would be both feasible and valid to track adherence to these practices for groups of patients with chronic conditions (like CHF), cared for by the medicine service lines represented on SKN, for three reasons: **1)** SKN participants by themselves are expected to touch many patients within these services; **2)** SKN participants constituted a critical mass of the total eligible medicine provider group; and **3)** knowledge exchanged on SKN, was expected and encouraged to be spread to peers, especially within participants' own service lines, since SKN exchanges were directly relevant to daily care practices in the hospital and clinics.

Data analysis

To address Aim #1, we examined dynamics of inter-professional knowledge exchange on the SKN system, using data from Yammer, supplemented with data from SKN Lunch-and-Learn sessions and SKN email updates. We began by conducting Thematic Analysis of data from Yammer, using QSR NVivo 14. The raw Yammer dataset consisted of a total of 485 posted communications, divided into 62 threads-of-discussion (distinguished by Thread ID). The entire dataset was organized by thread, in chronological order, which enabled Thematic Analysis to be conducted sequentially by thread, to understand dynamics of knowledge exchange, both by thread-of-discussion, and broadly, for the entire dataset.

The analysis team consisted of four researchers, 1 medical doctor (MD), 1 health service researcher (PhD), and 2 Graduate Research Assistants in the health sciences. To begin with, the first two researchers

completed all key phases of Thematic Analysis, to develop an initial coding scheme for identifying key themes. This included: 1) data familiarization; 2) search for themes; 3) review of themes; 4) defining and naming themes; and 5) generation of the initial coding scheme, including the "theme-node hierarchy" on NVivo. The initial coding scheme was used by the other two researchers to code approximately 33% of the raw dataset from SKN Yammer. Analysis of initial inter-coder agreement amongst the four researchers, revealed a 70% match. Follow-up discussions amongst the four researchers resulted in further refinements to the coding scheme. The revised coding scheme in turn, was used by all four researchers to recode entire raw dataset. This iterative process of coding, evaluation, discussions, and refinements to the coding scheme was repeated until final inter-coder agreement amongst the four researchers was over 95%. The next step was Thematic Analysis of content transcribed from the 5 SKN Lunch-and-Learn sessions and 15 SKN email updates, by the same coding team, using the final coding scheme developed for Yammer. The process revealed that no further changes were needed to the coding scheme.

To address Aim #2, we extracted and analyzed longitudinal patient-level data on our two measures, from the AU Health EHR, with support from a health system-based data analyst. We performed trend analysis of quarterly data on both measures, to understand patterns over time. We examined associations between *SKN Use* and *MU-of-EHR-MedRec*, by placing timestamps on trend charts to represent culminating points in inter-professional learning associated with the two measures, identified from Thematic Analysis, e.g., "Collective Learning (Aha) Moments" experienced during the SKN Lunch-and-Learn sessions. For MEASURE 1 (External Rx Import), we also analyzed comparative data for all patient encounters in the Neurosurgery service line, which was not represented on the SKN system. Comparative data was not available for MEASURE 2 (Missing Compliance Status Documentation).

Results

Dynamics of Inter-professional knowledge exchange and learning on the SKN system (Aim 1)

Of the 50 practitioners who signed up to SKN Users, 25 were active users of SKN Yammer, with 12 or more posts over the one-year SKN period. Active users of Yammer came from all professional subgroups and care settings represented on SKN, including 7 physicians, 8 nurses, and 10 pharmacists. Additionally, 3 of the 5 SKN Moderators (including the CMO, CMIO, and PI), each posted 40 or more messages on Yammer, over the one-year SKN period.

As indicated earlier, over the one-year SKN period there were a total of 485 posted communications on Yammer, divided into 62 threads-of-discussion. Of these, 45 threads had 3 or more posts; among which, 12 threads had 10 or more posts; of which 3 threads had 25 or more posts, including 1 thread with 45 posts. There were a total of 32 issues related to EHR MedRec reported on the SKN Reporting Tool, over the one-year period. Of the 45 threads with 3 or more posts, 32 began with issues reported on the SKN Reporting Tool, brought in to Yammer by SKN Moderators. As such, *all* reported issues were used to launch threads-of-discussion on Yammer.

Overall, the Thematic Analysis process identified six broad themes that were repeated across several threads of discussion, in the chronological order (outlined below):

1) Problem Statements
2) Problem-Solving Statements ("The How-To")
3) System Education ("The What")
4) Best-Practice Assertions ("The Why")
5) Culture Change Assertions ("The Way-To")
6) Collective Learning ("Aha") Moments

When the entire Yammer dataset and supplemental sources on SKN use (i.e., Lunch-and-Learn sessions and emails) were considered, there were several layers of sub-themes under each of the six broad themes. **Figure 2** summarizes this hierarchy of themes. In essence, this figure provides a foundation for broadly articulating the dynamics of inter-professional knowledge exchange related to EHR MedRec, on the SKN system.

A majority of issues related to EHR MedRec that were used to launch threads-of-discussion on Yammer (from the SKN Reporting Tool), pertained to the broad challenge of "communication across the provider continuum," within the context of "medication-list accuracy." To elaborate, one of the most voluminous threads (THREAD 1) began with a problem statement on obtaining medication history from the patient upon arrival, to formulate the current medication list, for reconciliation with new prescriptions, to create an accurate updated active medication list on the EHR. Another voluminous thread (THREAD 2) began with a problem statement on how medications that do not belong in the active medication list do not get removed at discharge, which in turn, reduces the accuracy of the patient's active medication list on the EHR. As such, two of the most voluminous threads on Yammer, pertained to problem areas most frequently encountered by practitioners in context of EHR MedRec, at a national level, as reported in the literature. **Figure 3** and **Figure 4** help to summarize the dynamics of inter-professional knowledge exchange in THREAD 1 and THREAD 2 respectively.

Dynamics of Inter-Professional Knowledge Exchange and Learning in THREAD 1

This subsection builds upon the details of *knowledge exchange dynamics in THREAD 1*, presented in Figure 3. The 2nd SKN Lunch-and-Learn session held at the start of Q2 of the SKN period, was devoted to discussing lessons learned on Yammer related to the "External Rx History Import" functionality on the EHR, which in turn, lay at the core of the Yammer discussions in THREAD 1. Correspondingly, this session was significant in providing an opportunity for collective learning on this topic. Several participating nurses and pharmacists who had used the External Rx History function, articulated how helpful it was in obtaining an initial medication history for supplementing with information from the patient/family, to develop a current medication list for reconciliation. This discussion in turn, culminated in several "*Collective Learning (Aha) Moments*," summarized by the PI at the end of the session: "*Lessons learned from Yammer, suggest that in the absence of an ideal scenario (e.g., dedicated resources for EHR MedRec or perfectly informed patients with all pill bottles), incremental efforts to improve practices with existing resources (e.g., External Rx Import), could go a long way in reducing medication discrepancies during transitions-of-care. In other words, doing something to reconcile medications (using External Rx Import), is better than doing nothing*, *for improving medication-list accuracy across the care continuum, to promote patient safety."*

Dynamics of Inter-Professional Knowledge Exchange and Learning in THREAD 2

This subsection builds upon the details of *knowledge exchange dynamics in THREAD 2*, presented in Figure 4. The 3rd and 4th SKN Lunch- and-Learn sessions held during the 3rd and 4th quarters of the one-year SKN period respectively, were devoted to discussing lessons learned on Yammer related to "Compliance Status Documentation," a key EHR MedRec functionality, which in turn, lay at the core of Yammer discussions in THREAD 2.

It would be relevant to note at this juncture, that around end of Q2 of the SKN period (i.e., ~6 months into SKN implementation), data collected up to that point, on the two EHR-MedRec-MU measures, began to be shared with SKN Users on Yammer (by SKN Moderators). At this point, data on MEASURE 1 had already begun showing substantial improvements, which in turn, was appreciated by Yammer participants. However, data on MEASURE 2 showed considerable room for improvement with a growing proportion of missing "Compliance Status" documentation, on patients' active medications. Supplemental chart audits that were performed by the CMO and CMIO/ SKN Moderators around the same timeframe, revealed a tendency to document only the "Not Taking" medications by exception, under "Compliance Status," while leaving other active medications, with missing "Compliance Status." These findings in turn, were shared with SKN Users on Yammer. As indicated on **Figure 2**, any postings on Yammer related to data on the two measures, were coded under the sub-theme of "*Data Discussions and Suggestions for Improvement,*" under the broad theme of "*Problem-Solving Statements*."

During the 3rd SKN Lunch-and-Learn session, a key topic for discussion was the importance of *not* leaving the "Compliance Status" missing for any active medication, since a blank field could be construed to mean either that the patient is "still taking the medication as prescribed;" or that the previous provider was "unable to determine" the status, making it all the more difficult for the next provider to trust the data in the

EHR, and use it meaningfully to update the medication list for the subsequent provider. It was discussed that these types of issues in turn, could prompt workarounds by each provider, to communicate any changes to the medication list directly to the patient, either verbally or on paper, without updating the electronic list on the EHR. These points were met with agreement from providers across the continuum. For example, an outpatient nurse coordinator commented: "*I have instructed my staff to address each medication with a compliance*." A Hospitalist physician commented: "*I agree. I would also like to see system-wide standardization of this process and education of responsible staff."*

The next (4th) SKN Lunch-and-Learn in turn, culminated in several "*Collective Learning (Aha) Moments*" on this topic, summarized by the PI at the end of the session: "*Our discussions on Yammer suggest that providers across the continuum must recognize the importance of shared ownership of EHR MedRec, since every provider's actions (e.g., 'Compliance Status' documentation), could affect the accuracy of the patient's active medication list on the system. Another key lesson learned, is that developing a collective understanding of both the value of best-practices related to EHR MedRec and the EHR MedRec workflow at a system level, is essential, before embarking on IT-training for providers to address socio-technical challenges (like managing differing 'views' of the EHR MedRec system). This shared understanding of the 'big picture' in turn, is essential, before resources are invested in IT-training of providers to address socio-technical challenges of implementation (e.g., differing screen-views across provider subgroups), to enable more meaningful communication across the care continuum*."

Associations between "SKN Use" and "Meaningful Use (MU) of EHR MedRec" (Aim 2)

Results for MEASURE 1 and MEASURE 2, are summarized in **Parts A and B** respectively, of **Figure 5.** The graph in Part A summarizes the trend in MEASURE 1, i.e., total proportion of External Rx History Import for all CHF encounters aggregated for the 5 participating medicine service lines, by quarter, over a 6-quarter period (Q1 2017-Q2 2018). The table in Part A indicates the numerators and denominators used to generate the proportions represented on the graph. Both the graph and table in Part A also include comparative data on MEASURE 1, for all encounters in the Neurosurgery service line, over the same timeframe.

As indicated, the aggregate proportion of External Rx History Import for CHF encounters in the 5 participating medicine service lines, increased (improved) from 35% in Q1 2017 to 84% in Q2 2018, a 140% increase. The vertical dotted line on the graph represents the time point of the 2nd SKN Lunch-and-Learn session (end of Q2/start of Q3 2017), which was conducted after several weeks of inter-professional discussion on this topic on SKN Yammer. The graph in Part A in turn, shows substantial improvement in MEASURE 1 from 59% in Q2 2017 to 85% in Q3 2017. On the other hand, the comparative data for Neurosurgery shows a relatively stable trend in MEASURE 1, with the aggregate proportion of External Rx History Import remaining at an average of ~45%, during the same timeframe. These dynamics suggest that the improvements in MEASURE 1 among the participating medicine service lines may have emanated from the inter-professional learning associated with this best practice on the SKN system.

Similar results were observed for MEASURE 2. The graph in **Part B, Figure 5** shows the trend in MEASURE 2, by quarter (from Q1 2017 to Q2 2018). The trend in MEASURE 2, is depicted separately for four groups of patients, distinguished by their total number of active medications in each quarter, over the 6-quarter period. In other words, patients who had <5 (**Group 1)**; >=5-to-<10 **(Group 2)**; >=10 **(Group 3)** total number of active medications in each quarter; and all patients with reported active medications **(Group 4)** in each quarter, over the 6-quarter period. The table in Part B shows the numerators (number of medications with missing compliance documentation) and denominators (total number of active medications), used to generate the proportions represented on the graph for MEASURE 2, for each group by quarter; as well as the patient count in each group, by quarter. The two vertical lines on the graph indicate the timings of the 3rd and 4th SKN Lunch-and-Learn sessions.

As indicated in **Part B**, MEASURE 2 showed an increasing (deteriorating) trend for all four groups from Q1 2017 to Q4 2017, during which time, an increasing trend was also noted in the total number of active medications among CHF patients (see table in Part B). However, MEASURE 2 began declining (improving) for **Group 1 after Q4 2017**. In other words, it went from 31% in Q4 2017 to 17% in Q2 2018 for Group 1; a

45% decline (improvement). As indicated on the graph, **Groups 2, 3, and 4** also began showing a decline **after Q1 2018**, i.e., one quarter after Group 1. However, the decline for Groups 2, 3, and 4, was not as sharp as it was for Group 1. The earlier start of decline (improvement) in MEASURE 2 for Group 1, compared to the remaining groups, suggests that the inter-professional learning that occurred related to this best practice during the 3rd SKN Lunch-and-Learn session, may have translated to immediate implementation of this best-practice among patients for whom it could be easily implemented, i.e., patients with <5 total active medications (i.e., the "low-hanging fruits"). However, the fact that there was a declining trend for all groups in Q2 2018 (relative to the substantially increasing trend in the earlier quarters), suggests that the trend in MEASURE 2 may be moving in the right direction for all patients, although there may be a longer learning curve for patients with more number of total active medications. As such, similar to MEASURE 1, the improvement in MEASURE 2 for the medicine services represented on SKN, coincided with the timeframe during which inter-professional learning on this topic, occurred on the SKN system.

Discussion

Over the one-year SKN period, there were two areas related to EHR MedRec (1) External Rx Import and (2) Compliance Status Documentation, for which inter-professional discussions on the SKN system progressed through the full spectrum of themes from "problem statements" to "collective learning (aha) moments," to lay a foundation for practice change. These learning dynamics in turn, were associated with improvements in both EHR-MedRec-MU measures. It would be relevant to note that we refrained from using broad outcome measures of "medication discrepancies" or "medication-list accuracy," because of the lack of 'truth' in what the accurate medication list was. This was further complicated by factors that can influence the 'accuracy' of the list from the view of the provider on either end of a transition point, in regard to what medications the patient 'should' be taking; and the view from the patient in regard to what they are actually taking. On the other hand, the two practice measures we have incorporated were most appropriate for our exploratory study, not only because they served as objective measures of Meaningful Use of the EHR MedRec system, but also because they directly emerged from the inter-professional discussions on the SKN as having the greatest potential to reduce medication discrepancies and promote medication list accuracy for patients at the study institution.

In regard to the participants who made a difference on the SKN, results suggest that SKN Moderators (e.g., CMO, CMIO, and the PI) played a crucial role in facilitating inter-professional knowledge exchange on issues related to EHR MedRec to promote collective learning of best practices. In both threads-of-discussion, initial "problem-solving statements" and "best practice assertions" often emerged from provider champions, which in turn provided a momentum for SKN Moderators to reinforce these messages. Additionally, although provider champions often emerged from among pharmacists and nurses, physicians also actively participated in corroborating best-practice assertions, when they were presented with evidence linking practices to outcomes. These gleanings suggest that healthcare managers must make conscious efforts to link practices to outcomes, to increase physician engagement in MU-of-EHR MedRec.

Implications for practice

Results from this exploratory study suggest that an SKN system could be a valuable tool in enabling EHR MU. From a broader perspective, SKN could be useful in enabling successful implementation of "complex innovations," i.e., practice changes requiring coordination of care across the continuum, with an additional layer of complexity posed by health IT implementation. In particular, results suggest that SKN helped achieve progress in MU-of-EHR MedRec, by addressing implementation-challenges in the correct sequence; i.e., by *first* enabling collective learning of the value of EHR MedRec, which in turn helped improve shared understanding of the system-level EHR MedRec workflow. Results suggest that this type of shared understanding of the "big picture," may be essential to have in place *before* embarking on any form of IT-training of practitioners, to address socio-technical challenges arising from EHR implementation.

Results also suggest that SKN may be a particularly valuable tool for institutions where practice change (e.g., EHR MU) needs to occur with existing resources, through workflow changes; as opposed to new resource outlays, e.g., dedicated pharmacy techs in every unit. In this regard, one may argue, that restricting the responsibility of EHR MedRec to dedicated resources, might hinder EHR MU, if there are sudden changes to the financial situation, and dedicated resources are not sustainable anymore. In such situations, engaging all provider subgroups in developing a shared understanding of the value of EHR MedRec and the system-level workflow, could payoff for any HCO.

This discussion in turn, provides insight into the following **evidence-based management strategies** for enabling successful implementation of complex innovations:

- At the start of the effort, create a knowledge sharing and learning mechanism (e.g., SKN) among a critical mass of providers, expected to implement practice changes. The mechanism should facilitate tacit knowledge exchange on issues experienced with current practices, as well as possible resolutions to those issues.
- Conduct proactive, periodic communications (from senior leadership) on benefits of adhering to best practices and consequences of not adhering to them.
- Create shared understanding of the value of best practices (i.e., the link between practices and outcomes) or the "why," to gain provider engagement in changing practices, before embarking on IT-training of providers to address sociotechnical (health IT) challenges.
- Develop capacity to collect, analyze, and disseminate data on best-practice measures among providers to promote a scientific (research-based) approach to learning and improvement.
- Enable champions for change to emerge from among providers, to voice the need for culture change for enabling successful best-practice implementation; and reinforce these messages with proactive, periodic communication from senior leadership.
- Create a "learning health system," by synthesizing lessons learned to facilitate "collective learning (aha) moments" across provider subgroups and care settings; and encourage providers to spread the learning within the broader institution. Management research has suggested framing practice issues as a "learning challenge" rather than a "performance challenge," and addressing them in the form of non-threatening pilot research projects, to engage providers in improvement. This project fulfilled both criteria to demonstrate meaningful results. This suggests that other health systems could also benefit from developing similar capabilities to become "learning health systems."

Implications for theory

Results and insights from this study serve to reinforce the theoretical framework described earlier, that communication networks rich in *brokerage* and *hierarchy* and lower *density,* i.e., proactive periodic top-down communication of best practices, may be effective in enabling tacit knowledge exchange, engagement, learning and change in HCOs. Additionally, while the original theoretical framework simply suggests that proactive, periodic top-down communication can enable tacit knowledge exchange, engagement, learning, and change in HCOs, results from this study provide profound insights into *how* inter-professional learning occurs in a HCO, to lay a foundation for practice change (MU-of-EHR MedRec), as summarized in **Figure 2**. While past studies have shed light on the factors enabling change implementation in HCOs (i.e., "*the what"*), there is limited understanding of how learning and change occur in HCOs (i.e., "*the how"*). By addressing this gap, this study lays a foundation for advancing theory on inter-professional learning in the context of complex innovation implementation, thereby making a significant contribution to the literature on change implementation in HCOs.

Limitations and future research avenues

This study is limited in being restricted to one health system, and like any other implementation study, it is influenced by context in which the practice (EHR MedRec) is implemented at the institution. Correspondingly, the practice implications are also "context sensitive." However, this may also be viewed as a strength of the study, in that, the prospective and exploratory study design helped gain insight into dynamics of inter-

professional learning, within the context of implementing new practices in a HCO, which in turn, helps address a key gap in the literature on *how* learning and change occur in HCOs. Future research could help to evaluate the generalizability of results from this exploratory study, through large-scale controlled experiments to investigate causal relationships between SKN Use and EHR MU, across a wide variety of HCOs. Another future research avenue would be to examine the utility of an SKN system as a tool for enabling successful implementation of other complex innovations involving coordination of care among multiple entities and health IT, e.g., risk assessment for sepsis prevention.

Conclusion

Results of this exploratory study show that SKN Use was associated with MU-of-EHR MedRec at the study institution. The study suggests an SKN system could be a valuable tool for enabling inter-professional knowledge exchange and learning to facilitate practice change (EHR MU). Future large-scale studies of SKN use in HCOs, could help to generate a systematic evidence-base of strategies for promoting EHR MU, which in turn, could be used to prompt federal EHR vendors to incorporate SKN features into EHR systems.

FIGURE 1

Effective Communication Network Structures for Learning and Change in Complex Systems Vs. Professional Complex Systems

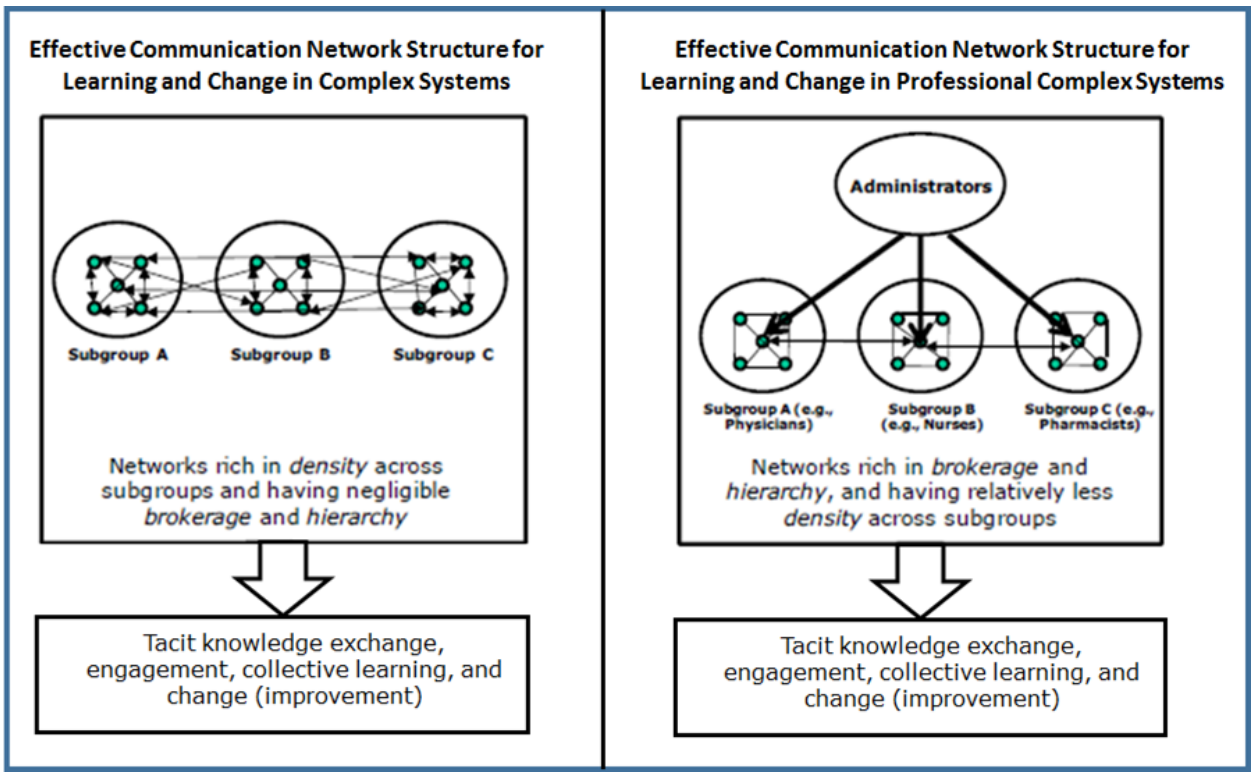


FIGURE 2

Dynamics of Inter-Professional Knowledge Exchange Related to "EHR MedRec" on the SKN System

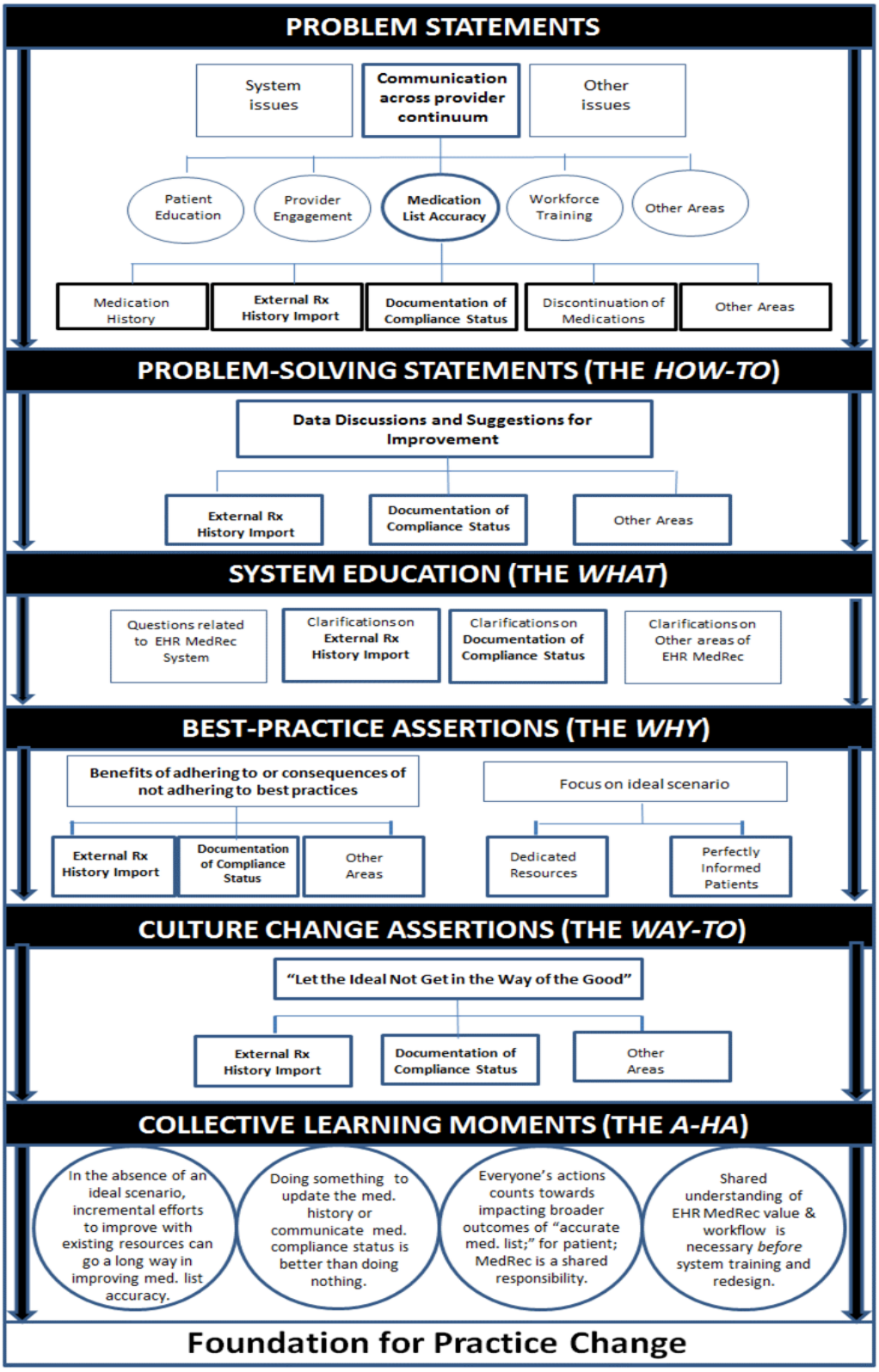


FIGURE 3
Dynamics of Inter-Professional Knowledge Exchange in THREAD 1

Problem statements

- THREAD 1 began with the "problem statement" from an ED nurse *"Patients frequently arrive to the ED with no medication list and they don't know the names of all or some of their medications …. The nurses typically attempt to put in what they know or have but it is incomplete a lot of the times…."* This concern was echoed by others. For example, a Cardiologist shared the following from an outpatient clinic perspective: *"Yesterday, I had a new patient who was on many medications but had neither the bottles nor a list. I cannot bill until meds are reconciled and yet this cannot be honestly done…."*

Problem-solving statements; spin-off problem statements; more problem-solving statements

- An outpatient nurse then put forth a "problem-solving statement" suggesting use of the External Rx History Import option, to obtain a current list of medications. *"We use the External Rx History option to populate the medication list when we have a NEW patient that does not bring their pill bottles. We have found this option to be helpful. Does ED have access to this system? It would at least give an idea of meds patient is taking and it does show last time med was refilled."*
- This suggestion initially received dissension from participants who had originally reported the problem. For example, the ED nurse shared: *"Yes we have the external history option, but it isn't as easy as one might think. You have to take the time to compare what is in the system to what is in the external history, and when they don't match up, you have to ask the patient …. some are insinuating that they will "trust" the history in the system, but it could be inaccurate."* The Cardiologist chimed in to say: *"Patients should bring in all home medications. I think importing the data in the absence of seeing the pill bottles creates errors."*
- This was then followed by problem-solving statements from a Hospitalist: *"I think there are few of us who fully trust any electronic list of meds. Usually I use it as a template to start discussing with patients what they're actually taking. Then once you have accurate medication lists the real question is compliance."*

System education

- This was followed by "system education" from the CMIO/SKN Moderator. *"The External Med is an option on the Medication List page. Ext Med shows last refill and often the prescriber. MDs can use this function as well to convert medication to prescription to populate medication list."*

Best-practice assertions and some dissension with focus on the ideal scenario

- Discussions progressed to "best practice assertions" from a pharmacist : *"Importing "External RX History" at some point in the patient encounter, preferably as close to admission as possible, is essential as it includes 90% plus of what actually occurred in the community. We all know there will be gaps (i.e. VA, cash paying, patient assistance medications, etc.). However, it will at least allow providers to know what the patient has been prescribed and could potentially question why they are not taking certain medications."*
- Similarly, the CMO/SKN Moderator shared: *"I am reviewing a case. Had the provider checked the external history, a verbal miscommunication would not have resulted in a dosing error."*
- Despite these assertions however, there was continuing disagreement with a focus on the ideal scenario: *"I think the only way to accurately reconcile medications is to see all the bottles the patient has."* There were also comments on the need for dedicated resources: *"I think the only way the ED can make this work would be to have help from pharmacy techs dedicated to only this task."*
- [NOTE: It would be relevant to note at this juncture, that AU Health has dedicated pharmacists and/or pharmacy techs in several outpatient and inpatient areas, but not in all departments].

Culture change assertions

- A pharmacist then put forth a "culture change assertion." *"It is important not to let the perfect stand in the way of the good or better, I have seen prescribers simply 'not act' to reconcile a medication because there was insufficient information or they were not sure. Not acting is making a decision (to do nothing)."* The CMO/SKN Moderator then reinforced this message with some comments:
- *"Many ED patients and even Hosp. to Hosp. transfers have little ability to give a med. history. That is why External Rx is so important. While not perfect, it does give fills of prescriptions with fill dates, and we have seen events that would have been prevented if this was done."*
- Regarding the issue of adding Pharmacy Techs to ED, the CMO/SKN Moderator commented: *"we would not be good stewards of our resources, unless we optimize the workflow and standardize it. Several of our clinics have already implemented these best practices and we need to spread them. Further role clarification is the key. Only after we do that would we know the resources needs. For example, a key process for our techs is to call pharmacies to obtain information. The best source even for them is the External Rx History since there is a lag in obtaining information from many pharmacies that do not operate 24x7."*

Collective learning moments

- The PI/SKN Moderator then posted the following in an effort to synthesize lessons learned: *"Our discussions suggest that incremental efforts to improve medication history with External Rx History Import, in the absence of dedicated resources, can go a long way in increasing accuracy of the medication list."*

FIGURE 4
Dynamics of Inter-Professional Knowledge Exchange in THREAD 2

Problem statements

- THREAD 2 began with a problem statement from an outpatient nurse: *"We are coming across multiple patients that were on two beta blockers. They had been switched from metoprolol to carvedilol or vice versa but both meds remained on their med list and the issue was not known until patients would call and state they were feeling very fatigued and heart rate was low - then we start investigating."* Another pharmacist echoed this concern: *"As new prescriptions are being written, the old ones are not being discontinued on the history. To tie into this issue, I have had several patients contact me asking to remove a medication from their list that they have never been prescribed."*

Problem-solving statements; spin-off problem statements; more problem-solving statements

- An outpatient nurse then advanced an initial "problem-solving statement" for using the "Compliance Status" field, to indicate "Not Taking" with additional notes as needed, to indicate formulary replacement or completed course; and just removing the medication. *"If the patient is no longer taking the medication, why not just right click and select complete and it's gone? You could notate the reason for removing prior to completing under Compliance Status so that when the next person reviews inactive/discontinued meds they'll see the rationale."*
- However, a Hospitalist physician had a disagreement: *"There are cases that patients are no longer taking medications but probably need to be taking them. In such cases, discontinuing the medication would not be appropriate."*
- This was followed by additional "problem-solving" comments from a pharmacist: "It *would be helpful to have "not taking – told to stop by doctor" versus "not taking - non-compliance" in addition to "not taking - unable to determine" which we already have, to provide more information into what barriers/issues exist for adherence and access."*

System education

- The CMIO/SKN Moderator then stepped in with some "system education." *"Under Compliance Status, 'Not Taking' was meant for meds that the patient was supposed to be taking but are not compliant with. Intake staff were supposed to "complete" meds that had been discontinued by a provider or that the patient self-discontinued. Of course there is some gray area between the two, which would be a clinical judgement call."*

Best-practice assertions

- This was followed by several "best practice assertions" from pharmacists and nurses, to reinforce the benefits of Compliance Status documentation for every active medication; as well as the consequences of not doing so: *"Correct medication list is essential for a patient to move from hospital to the community physician. Discontinuing 'Not Taking' Medications needs to occur at the point of entry or exit from the acute care stay. As such, completing the Compliance Status for every medication during every encounter is essential. Compliance status can be assessed by fill history and asking the patient how they take their medications (e.g., if prescription is for Lisinopril 20 mg daily, #30, for 12 refills; and fill history only shows one fill over 6 months, then patient is either non-compliant or was told to stop taking the medication)."* Another pharmacist commented: *"The issue generally starts with the medication plan being verbally communicated to the patient and not completely written down. In such cases, the lists would not include 'the following medicines have been discontinued,' which in turn, leads to therapeutic duplication."*
- Concurrently however, there were comments from other pharmacists that stressed the need for dedicated resources *"I have read that pharmacy techs are very effective in solving these problems as they are familiar with the medications, regimens, refill patterns, etc. This effectiveness comes from looking at the information on a daily basis."*

Culture change assertions

- Next, a pharmacist who made a similar comment in the context of the discussion on External Rx History Import put forth a "culture change assertion." *"Again, it is important to not let the perfect be the enemy of the good. I agree that if the Compliance Status is 'not taking' anymore, that needs to be flagged so the next prescriber is aware and can consider the information (e.g. not ordering a medication for a patient who has not taken for years - AND removing the med from the list of active medications). This is NOT prescribing, but should be done with a note on the specifics - e.g. "stopped due to side effects" versus "the specialist who prescribed it told me to stop." These have different implications that the clinician needs to consider)." Having partial information on the drug name is better than no information at all, as long as this is flagged by the team for follow-up, e.g., for an inpatient admission that might be asking the family to bring the Rx in, or calling a physician's office/pharmacy the next morning."*
- These comments were then reinforced by the CMO/SKN Moderator: *"To require all areas documented would put the documenting individual in a tough position. Sometimes you do not know at the time what dose is! What do you do? Do not document the med at all? Documenting the med at least allows interaction checks. So as <the pharmacist> said, let's not allow perfection to become the enemy of good. The key is to teach the importance of compliance and how to document it."*

Collective learning moments

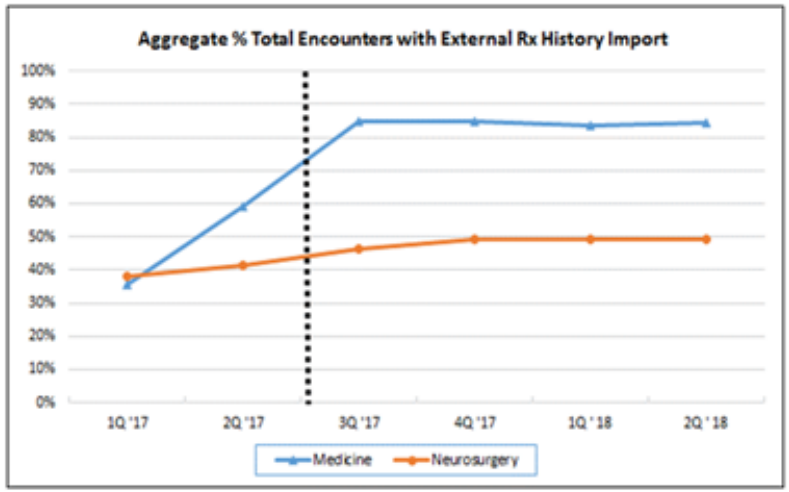
- The PI/SKN Moderator then made the following comment, in an effort to synthesize lessons learned from the discussion: *"This discussion illustrates how the actions of each provider or clinic in completing or not completing the Compliance Status field, can impact the accuracy of the patient's medication list and ultimately, the safety of the patient as s/he transitions into the community."*

FIGURE 5

Trends in Measures of Meaningful Use (MU)-of-EHR MedRec*

PART A

MEASURE 1: External Rx History Import (*Higher is Better*)

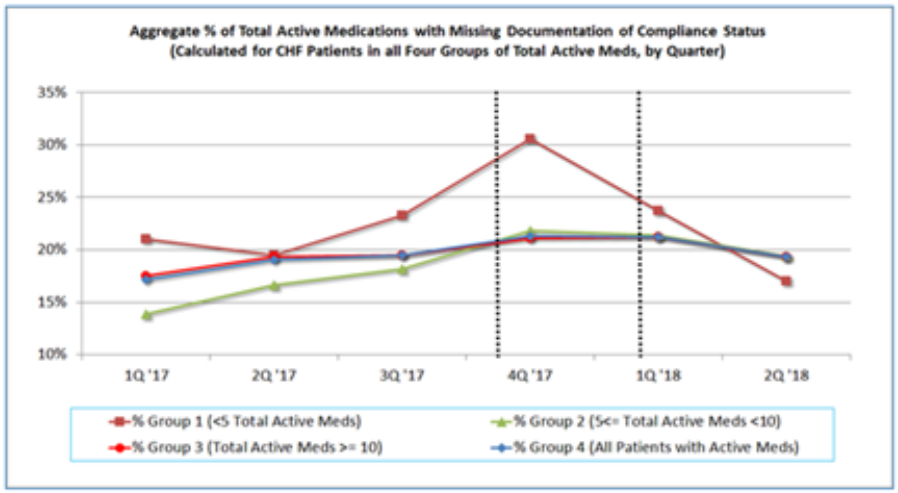


NOTE: The vertical dotted line on the graph, represents timing of the 2nd SKN Lunch-and-Learn session

	1Q '17	2Q '17	3Q '17	4Q '17	1Q '18	2Q '18
Number of External Rx History Imports (All 5 Medicine Service Lines)	455	706	1063	1027	1123	1215
Total Number of Congestive Heart Failure (CHF) Encounters (All 5 Medicine Service Lines)	1286	1193	1254	1212	1343	1441
Aggregate Proportion of External Rx History Import (Medicine)	**35%**	**59%**	**85%**	**85%**	**84%**	**84%**
Number of External Rx History Imports (Neurosurgery Service Line)	452	441	456	494	547	496
Total Number of Encounters (Neurosurgery Service Line)	1186	1064	988	1000	1113	1005
Aggregate Proportion of External Rx History Import (Neurosurgery)	**38%**	**41%**	**46%**	**49%**	**49%**	**49%**

PART B

MEASURE 2: Missing Compliance Status Documentation (*Lower is Better*)



NOTE: The two vertical dotted lines on the graph, represent timings of the 3rd & 4th SKN Lunch-and-Learn sessions

	1Q '17	2Q '17	3Q '17	4Q '17	1Q '18	2Q '18
Number of Meds Missing Compliance Documentation in GROUP 1	160	150	155	182	111	55
Number of Meds Missing Compliance Documentation in GROUP 2	335	448	505	590	461	263
Number of Meds Missing Compliance Documentation in GROUP 3	2591	3900	5240	7262	9251	11071
Number of Meds Missing Compliance Documentation in GROUP 4	3086	4498	5900	8034	9823	11389
Total Number of Active Meds in GROUP 1	761	771	666	595	468	324
Total Number of Active Meds in GROUP 2	2412	2693	2783	2700	2157	1354
Total Number of Active Meds in GROUP 3	14787	20179	26874	34387	43583	57226
Total Number of Active Meds in GROUP 4	17960	23643	30323	37682	46208	58904
Count of all CHF patients in GROUP 1	250	256	217	194	158	112
Count of all CHF patients in GROUP 2	329	371	379	368	296	181
Count of all CHF patients in GROUP 3	663	868	1112	1407	1715	2024
Count of all CHF patients in GROUP 4	1242	1495	1708	1969	2169	2317

**De-identified raw data files used to calculate these measures are available upon request.*

List of Publications and Disseminated Work[2]

Project Title: "Using Social Knowledge Networking (SKN) Technology to Enable Meaningful Use of EHR MedRec Technology"

Grant Award Number: R21HS024335

Manuscripts under review with peer-reviewed journals (Submitted: October 2018)

- **Rangachari, P.,** Dellsperger, K.C, Fallaw, D., Davis, I., Sumner, M., Ray, W., Rethemeyer, R. (*Under Review*). Dynamics of Inter-Professional Learning Related to Electronic Health Record (EHR) Medication Reconciliation (MedRec) within a Social Knowledge Networking (SKN) System.

Peer-reviewed journal articles (published)

- **Rangachari, P.** (2018). Implementing a Social Knowledge Networking (SKN) System to Enable Meaningful Use of an EHR Medication Reconciliation System: A Study Protocol. *Risk Management and Healthcare Policy*; 11: 45-53; PMID: 29618941.
  PubMed Link: https://www.ncbi.nlm.nih.gov/pubmed/29618941.
- **Rangachari, P.,** Dellsperger, K.C, Fallaw, D., Davis, I., Sumner, M., Ray, W., Fiedler, S. Nguyen, T. Rethemeyer, R. (2018). Creating a Foundation for Implementing an EHR-Integrated Social Knowledge Networking (SKN) System on Medication Reconciliation; *Journal of Hospital Administration*; 7(2): 36-49. doi:10.5430/jha.v7n2p36. PMID: 29682132.
  PubMed Link: https://www.ncbi.nlm.nih.gov/pubmed/29682132
- **Rangachari, P.** (2018). Innovation Implementation in the Context of Hospital QI: Lessons Learned and Strategies for Success. *Innovation and Entrepreneurship in Health*; 5: 1-14.
  Publication Link: https://www.ncbi.nlm.nih.gov/pubmed/29546884

Peer reviewed abstracts (published)

1. **Rangachari, P.** Dellsperger, K.C, Fallaw, D., Davis, I., Sumner, M., Ray, W., Rethemeyer, R. (2017) Setting the Stage for Implementing an EHR-integrated Social Knowledge Networking (SKN) System on Medication Reconciliation. *AMIA Annual Symposium Proceedings;* 2017: 2172. https://knowledge.amia.org/65881-amia-1.3897810/t004-1.3900473/f004-1.3900474/2729722-1.3900763/2729722-1.3900764
2. **Rangachari, P.,** Dellsperger, K.C, Fallaw, D., Davis, I., Sumner, M., Ray, W., Fiedler, S. Nguyen, T. Rethemeyer, R. (2018). Setting the Stage for Implementing an EHR-Integrated SKN System on Medication Reconciliation; *Academy of Management Annual Meeting Proceedings,* August 2018. https://journals.aom.org/doi/10.5465/AMBPP.2018.11296abstract
3. **Rangachari, P.** (2018). Innovation Implementation in Hospitals and Health Systems: Lessons Learned and Strategies for Success. *Academy of Management Annual Meeting Proceedings,* August 2018. https://journals.aom.org/doi/abs/10.5465/AMBPP.2018.11906abstract

Peer-reviewed national conference presentations (presented)

1. **Rangachari, P.**, Dellsperger, K.C, Fallaw, D., Davis, I., Sumner, M., Ray, W., Fiedler, S. Nguyen, T. Rethemeyer, R. Creating a Foundation for Implementing an EHR-Integrated Social Knowledge Networking (SKN) System on Medication Reconciliation; Presented, *Academy Health* Annual Research Meeting, New Orleans, LA, June 2017.

[2]Please note that the publications & presentations we have had thus far from this R21 project, have been from PHASE 1 of this project. Our dissemination efforts from PHASE 2 (the main intervention phase) have only now begun. Data collection for PHASE 2 was concluded in June 2018; and was followed by data analysis in PHASE 3 which in turn, was concluded in September 2018. We have now submitted our first manuscript from PHASE 2 for review with a peer-reviewed journal. We have two more full-length manuscripts under preparation. Additionally, we are planning to submit papers & abstracts from PHASE 2 to two national and international conferences to be held in 2019. Correspondingly, dissemination efforts from PHASE 2 of this project are expected to continue through 2019 and beyond. We will be sure to inform our Project Officer at AHRQ, Dr. Janey Hsiao of every future accepted work from PHASE 2 of this R21 project.

2. **Rangachari, P.**, Dellsperger, K.C, Fallaw, D., Davis, I., Sumner, M., Ray, W., Fiedler, S. Nguyen, T. Rethemeyer, R. Using Social Knowledge Networking (SKN) Technology to Enable Meaningful Use of EHR Medication Reconciliation Technology. Presented, *American Public Health Association* 145th Annual Meeting, Washington, D.C., November 2017.
3. **Rangachari, P.**, Dellsperger, K.C, Fallaw, D., Davis, I., Sumner, M., Ray, W., Fiedler, S. Nguyen, T. Rethemeyer, R. Setting the Stage for Implementing an EHR-Integrated SKN System on Medication Reconciliation. Presented, *American Medical Informatics Association* Annual Meeting, Washington D.C., November 2017.
4. **Rangachari, P.** Fallaw, D., Davis, I., Sumner, M., Ray, W., Fiedler, S. Nguyen, T. Rethemeyer, R. Setting the Stage for Implementing an EHR-Integrated SKN System on Medication Reconciliation; Accepted: *Academy of Management 78th Annual Meeting*, Chicago., IL, August 2018.
5. **Rangachari, P.** Innovation Implementation in Hospitals and Health Systems: Lessons Learned and Strategies for Success; Accepted: *Academy of Management 78th Annual Meeting*, Chicago., IL, August 2018.

Invited national scholarly panel presentation (presented)

- **Rangachari, P.** (Invited Panelist). Building Capacity to Integrate Implementation and Organizational Sciences: A Professional Development Workshop, *Academy of Management 78th Annual Meeting*, Chicago., IL, August 2018.

Link to Augusta University's News Story on this Project (Feb 2018)

http://jagwire.augusta.edu/archives/51582